MAKING SENSE OF ROCKET SCIENCE—

BUILDING NASA'S KNOWLEDGE MANAGEMENT PROGRAM

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The National Aeronautics and Space Administration (NASA) has launched a range of KM activities—from deploying intelligent "know-bots" across millions of electronic sources to ensuring tacit knowledge is transferred across generations. The strategy and implementation focuses on managing NASA's wealth of explicit knowledge, enabling remote collaboration for international teams, and enhancing capture of the key knowledge of the workforce. An in-depth view of the work being done at the Jet Propulsion Laboratory (JPL) shows the integration of academic studies and practical applications to architect, develop, and deploy KM systems in the areas of document management, electronic archives, information lifecycles, authoring environments, enterprise information portals, search engines, experts directories, collaborative tools, and in-process decision capture. These systems, together, comprise JPL's architecture

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[1] Many of the thoughts and ideas within this article were discussed at a workshop in November 2000 with the members of the NASA Knowledge Management Team. Their thoughtful insights, contributions, and suggestions formed the basis of the ideas set forth here. Key contributors included Lee Holcomb, Michael Little, Stephan Naus, Len Japngie, Michael Bell, and Charlotte Linde. A full list of team members is noted at the end of this article. More information can be found at http://km.nasa.gov.

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to capture, organize, store, and distribute key learnings for the U.S. exploration of space.

This paper sets forth the strategic plan for knowledge management at NASA and discusses some of the early pilots at the Agency level. Many places in NASA are proceeding with good, solid work in knowledge management, but this paper will focus on the approach, architecture, and services being delivered by the Jet Propulsion Laboratory's Knowledge Management Project.

~~7.~~ INTRODUCTION

In the days when the vast array of NASA's resources was focused on a few long-duration programs (such as Apollo or Space Shuttle), NASA had the luxury of people sharing knowledge throughout the program. Engineers and scientists spent years, sometimes decades, working on a project, learning from the senior members and eventually mentoring junior team members. As an Agency, NASA's knowledge base and abilities continued to grow. In today's environment at NASA, engineers and scientists may work one to three years on a project and then move on. While they may build richer individual knowledge, the institutional knowledge base has shrunk as many of those individuals have retired or left NASA. New employees are tossed into a maelstrom of project implementation activities and expected to perform without any substantial introduction to NASA's processes, history, culture, and lessons learned. Rather than advocating a return to days of large projects, knowledge management offers a solution for moving ahead, acknowledging today's constraints and adapting to a world where technology and innovative processes must partially replace the mentoring and measured approaches of the past.

NASA's knowledge, its intellectual capital, is the Agency's only sustainable source of competitive advantage. Physical assets age, today's workforce is mobile, and technology is quickly bypassed. NASA's knowledge as an Agency, however, can endure. This knowledge is a fluid mix of experience and know-how that allows NASA employees to strive for and achieve the improbable day after day.

Knowledge management is the spark that will ignite NASA's ability to get the most from the investments it has made in workforce and information technology, and to harness the considerable intellectual capital within the Agency and its partners. KM is more than a technology thrust, but will build upon technology and information to help guide NASA through the intricacies of working with international teams and making ever-more-complex decisions.

The three key areas upon which NASA needs to move forward to more effectively manage its knowledge are

- Capturing more of the critical knowledge NASA needs to safely conduct missions
- Enabling virtual teams to work collaboratively at peak efficiency
- Managing more effectively the information that has already been captured

Those companies whose cultures promote knowledge sharing and individual learning have high employee retention, attract high-quality employees, and have a workforce that focuses on fixing the problem rather than fixing the blame.

As NASA takes the first steps in managing its knowledge, it is focusing on ensuring that it avoids previous mistakes, as well as optimizes the learning from its successes. Knowledge management is at the heart of NASA's ability to invest the time and money to fly safely today while leaving a unique and irreplaceable legacy for the future of NASA and the Nation.

~~7.~~ MISSION AND VISION

NASA's mandate to deliver leaner, more demanding, and increasingly more complex missions has resulted in a dependency on creating multidisciplinary teams, building alliances with contractors, and quickly and dynamically linking to and learning from other Agency activities. Managers have a new need to quickly identify the right people for teams, take advantage of NASA's rich pool of experience, rapidly and broadly share information across organizational boundaries, and fully understand the range of the Agency's people, process, and technology resources.

> **KM plays a vital role in driving a learning culture, encouraging knowledge sharing, and supporting better decision making.**

This impetus to manage knowledge comes down to understanding and applying a simple concept:

People + Information = Action

- **People**—The *employees* of NASA and its partners, the public, the Government, and the technical community.
- **Information**—Specific *learnings* that can be communicated between people (verbally, in writing, or through a method or process).
- **Action**—A *decision* or task that measurably improves the performance of the Agency or its partners, another organization, or an individual.

When people are given access to the information and resources they need to complete a task, they can finish it faster, better, and cheaper. An engineer selecting a part for a sensor, a scientist analyzing data from an experiment, a manager selecting among various new technologies—all these actions are more likely to succeed if the people have better, faster, easier access to pertinent information about what has worked before and who has made the same analyses. *Knowledge management is the key to helping bring the right information to the right people at the right time.*

Knowledge management—facilitating the sharing of knowledge—occurs when people have easy access to and use tools and processes provided to help them solve problems and achieve understanding. KM provides the environment in which knowledge sharing and learning lead to actions in support of the Agency's goals (Figure 1). Given the highly distributed, "virtual" teams at NASA today, KM's challenge is to bring together people and their expertise across barriers of time, space, and culture.

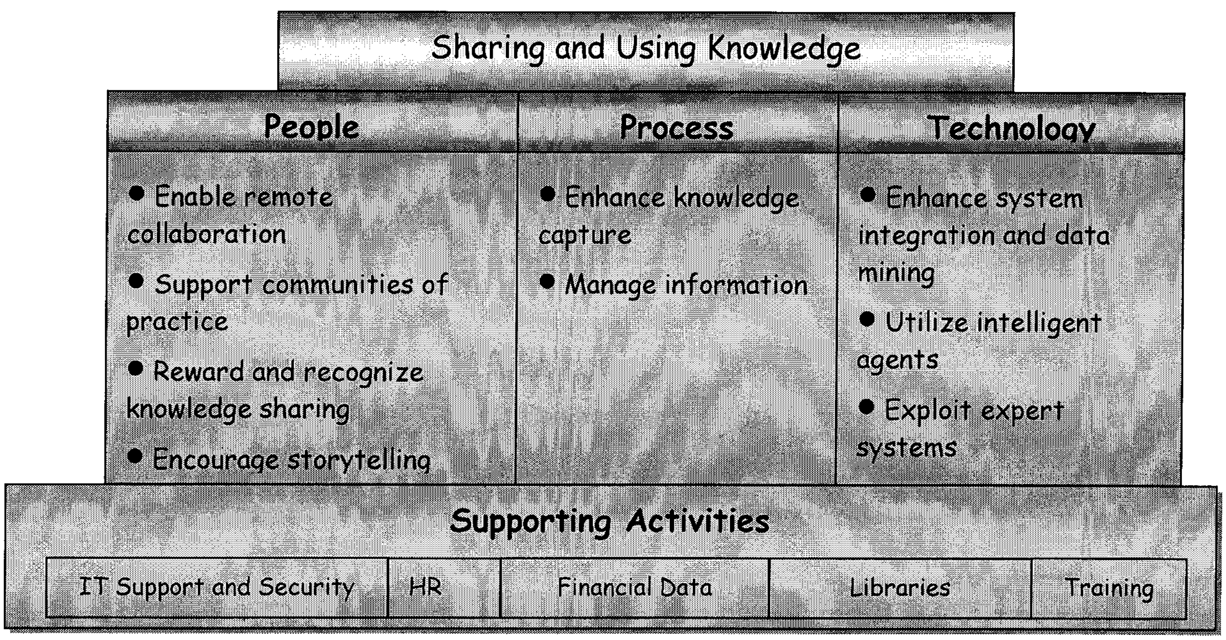

Figure 1. Knowledge management activities will build upon existing capabilities.

As a result, there are three priority areas where KM will help NASA's ability to deliver its missions:

1. To sustain NASA's knowledge across missions and generations ***KM will identify and capture the information that exists across the Agency***

2. To help people find, organize, and share the knowledge NASA already have ***KM will help to efficiently manage the Agency's knowledge resources***

3. To increase collaboration and to facilitate knowledge creation and sharing ***KM will develop techniques and tools to enable teams and communities to collaborate across the barriers of time and space***

Knowledge management (KM) enables organizations to capture, organize, analyze, share, and reuse both explicit and tacit knowledge to make better and faster decisions across geographic, functional, and team boundaries. *The cornerstones of NASA's KM system are people, processes, and technology—all three aspects are needed to capture and harness the knowledge within NASA.* The KM framework focuses on collecting sources of information to enhance the quality of the actions based upon that information and to facilitate creation of knowledge.

> **Knowledge management is getting the right information to the right people at the right time, and helping people create knowledge and share and *act* upon information in ways that will measurably improve the performance of NASA and its partners.**

GOALS

The strategies for developing a KM program are based upon requirements gathered from NASA's cross-cutting processes, as well as from other internal activities and external organizations. Knowledge management is committed to supporting the Agency's goals of enhancing mission safety and success, inspiring the human spirit, advancing and communicating scientific knowledge, furthering human exploration of space, and developing new technologies. Specifically, KM's goals are to

Competency Management at KSC

Knowledge Management at the Kennedy Space Center takes on a human resources focus. A major project underway is developing a systematic method for understanding the competencies of the current skill base on the Center, and then developing a method to maintain, develop, or acquire high-priority competencies that are vital to the success of key strategic areas. The newly appointed "Knowledge Managers" in each organization are critical to making this happen.

KSC depends heavily on operational experience to build skills in the workforce (both craft and professional). Civil servants are moving out of daily operations and more experienced people are retiring. In the future, skills will be maintained using a different ratio of knowledge and experiences: less experience and more explicit knowledge and tacit knowledge transfer. KSC's KM program seeks to enhance the transfer of tacit knowledge to the future workforce through mentoring and networking. A key role of the Knowledge Manager at KSC is to manage gaps between current and future knowledge needs. This includes skill maintenance and growth, documenting competency types and levels, and organizational development planning (succession planning and training).

--Michael Bell, Kennedy Space Center, NASA

- Improve the Agency's ability to deliver knowledge to employees, partners, and citizens in timely and useful ways
- Increase the ability of communities to communicate and collaborate
- Expand innovation and creativity across teams

The primary customers of KM services are scientists and engineers on NASA's missions and projects, program and project managers, Agency employees and contractors, and the public, including educators and policy makers. A key focus is the program and project management community. NASA employees, too, will benefit from having quick access to a vast and powerful array of resources available to them to improve their effectiveness. The public will benefit from improved access to and products in education, technology, and science. A thoughtful approach to KM can, in fact, provide an architecture and enabling services to many different groups within NASA and between NASA and its partners.

Imagine yourself in a future knowledge-enabled NASA...

You have a great idea for an Earth-orbiting satellite that will seek out and collect 10% of all on-orbit debris, chemically bonding it to the satellite, thereby making shuttle and Space Station operations safer and delivering a significant cost savings to the tracking operations at the Deep Space Network. You see an Announcement of Opportunity (AO) and decide to submit a proposal. You already have a group of folks you know would be good—some at NASA Centers, a clear industry partner, and researchers at universities in Russia and Canada. At the kickoff videoconference for the AO, you were given access to the Program and Project Management portal, which gave you many of the capabilities you need to work with your team.

As you start chatting online, you realize you also need to involve a chemist. The portal links you to a directory of experts across NASA, you narrow your search to a chemist at Goddard who has recent experience on a flight instrument—you can read *her publications and see the notes and webcast video clips from an international workshop she recently led.*

You want to send out some information to your team, so you go to the portal and establish a forum for ideas on the technology innovation and set up a robotic agent to search for articles and postings on chemical bonding. You really need to talk to your team face-to-face, so you schedule a desktop videoconference for your team and DSN and shuttle experts (you found the experts in the directory and can schedule across everyone's calendar), then you reserve a room and time for a working meeting at another location for a follow up discussion. You see your team members putting up lots of ideas and many postings coming from the "knowbot" agents—it's like having extra people researching for you!

As the proposal effort proceeds, your team uses the portal to publish and retrieve ideas, working documents, and links to related information. (In the background, you know the system is marking certain documents for long-term archive, as well as ensuring you will be compliant with Federal and statutory regulations.) At a critical design point, another knowbot in the system notifies you that a specific lesson learned on a previous project may be applicable given your current design parameters. You review the lesson and the decision tree and design trade-offs related to it, and realize that the flight environments are different, so you're probably okay. You note the lesson and its attendant data should be reviewed again at design review—you can include the author of the lesson at your review.

Congratulations! You win the proposal and you begin working on moving from your proposal concept to actual implementation. You already have a working environment that you are familiar with and that contains all your research and documentation. You can hit the ground running.

~~7.~~ ROADMAP

Moving from where NASA is today will be difficult—from scattered islands of information, distributed databases, and isolated experts—to where it must be—with tightly linked information resources and experts easily identifiable and accessible.

While all of the changes will present challenges, some are straightforward and thus will be easier to achieve. These near-term milestones relate to enhancing existing processes or augmenting or adding technologies to better access and manage information. These changes can be brought about through judicious application of time and money.

The more difficult—and in the end more critical—challenge lies in embracing knowledge sharing in a way that preserves NASA's innovative spirit, effectively manages constraints, and stays focused on the greater goals of the Agency while meeting tight mission deadlines. Today's environment is one of tightly focused, task-specific missions that discourage, due to time constraints, sharing between projects or organizations. Tomorrow's NASA must become one where tasks are interwoven to encourage knowledge sharing to achieve NASA's goals. In this area, the essential changes are cultural—modifying how people are rewarded for sharing information, giving people the time to make information reusable for others, and adapting or adopting previous best practices.

Many areas within the Agency have already chosen to implement KM on a smaller scale and have initiated local efforts to manage their knowledge. For example, education and training programs, collaborative tools, mentoring programs, document management systems, and online communities already exist, but in most cases, in isolation. KM will build upon and bridge the existing capabilities and resources to deliver an integrated suite of processes and tools to help share information across the Agency. KM is the next stage in identifying and capturing the Agency's information, bringing together disparate resources, building the framework and providing the "glue" to enable integrated access, and delivering that information and capability to employees, missions, and partners. Since projects and missions focus on specific tasks, **it falls to KM to look beyond single endeavors and focus on the long-term: to invest in building the capabilities to share and manage knowledge over many projects and initiatives.**

The major areas to start working on (Figure 1) are encouraging and supporting *people* sharing information, enhancing the *processes* by which information is captured

Managing Information at Marshall

The Virtual Research Center (VRC) is a web-based project-management information system. Tools within the VRC include a document manager, an action item tracker, a calendar, a team directory, a threaded discussion tool and an activity log. Each team using the VRC has a password protected area known as a wing. Potential team members apply for a badge by filling out an online form. Team leaders can approve membership with the click of a button and the VRC automatically generates an account for the new team member.

Since opening its virtual doors in 1997, the VRC user community has grown to more than 3300 registered users on over 175 project teams. Today, close to 15,000 files are stored in VRC team libraries. Over the past three years, the VRC development team has refined the interface and added functions based on comments from the user community. One example of an implemented suggestion is the team directory, which is automatically populated with data from approved badge request forms.

Current development efforts include incorporating object-oriented software technologies. With an object-oriented architecture, the VRC will serve as an environment for both knowledge management and collaborative engineering. Tools within the VRC, such as a threaded discussion tool, provide the capability for teams to describe experiences and thought processes. A search engine provides the capability to search through 75 different file formats for keywords. As legacy codes become integrated with the system, the VRC will automatically capture metadata associated with design analysis.

--Daniel O'Neil, Marshal Space Flight Center, NASA

and managed, and augmenting or building new *technologies* to make this happen. Initial priorities relate to enhancing knowledge capture, managing information, and enabling remote collaboration for virtual communities.

~~7.~~ NASA Internal KM Efforts

The proposed direction for KM comes from analysis of best practices and an assessment of where NASA is today. As stated earlier, two essential areas to focus on involve enhancing the ability (1) to capture and understand the knowledge that is already captured (this is a popular first step with many organizations) and (2) to create a knowledge-sharing culture.

KM thrusts:

- **Capturing information**
- **Managing the knowledge at NASA**
- **Building tools for collaborative communities**

Some activities at NASA are already supporting or plan to support KM-type tasks. In an assessment of the suite of databases operated across the NASA, the best of them share features that result in their success as KM tools. This success is evidenced by:

- Increased efficiency attributed to the KM application (for example, through hours saved in searching for or distributing information)
- Frequency of use and number of users
- Number of informational connections made by the user community
- Secondary successes through problem avoidance or latent recollection
- Project initiation simplified through use of "corporate experience" stored in the knowledge repository
- Preservation of NASA knowledge in a searchable form

The best of these systems shared the following attributes:

- High accessibility, searchability, and ease of use
- Potential to save a large amount of work and/or potential to help avoid expensive problems
- Dense data repository
- Features such as online help, help desk, and frequently asked questions
- Openness to unsolicited submissions of information
- Accurate and maintained information[2]

Three early knowledge management pilots are looking at the architectural approach to KM at the Agency as a whole. If distributed teams can access information easily, find experts for support and consultation, and share key learnings, then KM can succeed at NASA. As a result of these ideas, three pilots were proposed and chosen to understand these issues. The work on these pilots was funded by NASA's Chief Information Officer and conducted at the Jet Propulsion Laboratory, Langley Research Center, and Goddard Space Flight Center.

- **Sharing Key Learnings**. KM has already completed a redesign of the Lessons Learned Information System (LLIS) to better capture and infuse lessons learned into day-to-day activities on projects. The focus of the redesign has been to deliver key information to an employee at the time they are making a critical decision on a project, and to ease the capture, approval, and distribution of formal and informal lessons learned. The new system is

[2] Based on research by Len Japngie, NASA, Washington DC, November 2000.

envisioned to provide a subscription service for specific lessons learned tailored to user-defined interests.[3]

- **Accessing Information**. Acting as an integrator of many different news and information sources, a portal is an electronic gateway that offers easy access to online resources through a personalized home page that collects the links, headlines, and business applications that are most relevant to the user. (Some samples of commercial portals include My Netscape and Excite.) A prototype NASA portal is operational at one location, with plans for expansion to multiple Centers and to host Agency-wide news and information. This portal provides the cornerstone technology for communities to find, search, publish, and share general news and information.[4]
- **Finding Experts**. A pilot directory of experts is being tested to investigate the feasibility of automatically creating and updating profiles of experts. With feeds directly from the Human Resources database, the experts' directory contains profiles of many people across the Agency. Working with academicians at the University of Maryland, Baltimore County and Florida International University, the Experts Directory is investigating mining web-based biographies from trusted sources.[5]

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[3] See more at http://llis.nasa.gov

[4] See more at http://insidejpl.jpl.nasa.gov

[5] See more at http://that.gsfc.nasa.gov/dev/ExpertDir/Direx.htm

~~7.~~ KM Implementation at JPL[6]

One of the first NASA facilities to begin a serious campaign in knowledge management, the Jet Propulsion Laboratory has taken an architectural approach to selecting and implementing key KM components that will facilitate knowledge sharing and reuse. KM will accomplish some of its objectives through deployment of portals (customizable web sites that provide targeted information to people and allows them to publish to specific communities), enhanced capture and distribution of key learnings for individuals and projects, support for the development and growth of communities of practice, and creation of collaborative environments to enable sharing and managing of the knowledge developed within a community.

At the Jet Propulsion Laboratory (JPL), the Knowledge Management (KM) Project oversees a variety of integrated activities that, together, are intended to lead JPL closer to a culture and environment where it is easy for people to share and learn from each other and their work. Started in 1999, the KM Project is organized to study the following areas noted in Figure 2.

[6] The work detailed in the JPL case results from the efforts of many people, including Jim Doane, Tom Renfrow, Roger Lee, Douglas Hughes, Tom Antzcak, Manson Yew, Jayne Dutra, Lynne Cooper, and Katherine Dumas. More information can be found at http://km.jpl.nasa.gov.

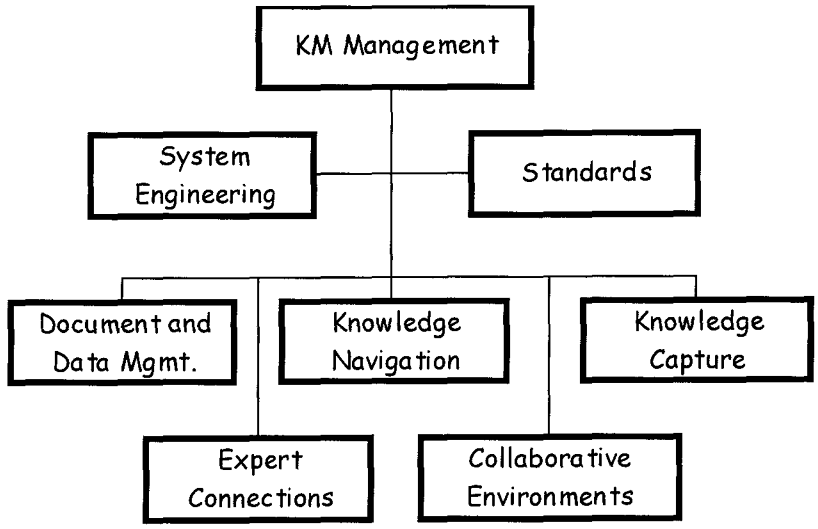

Figure 2. JPL's KM Organization

Each area is responsible for tracking trends in the field, surveying internal best practices and benchmarking with external partners, coordinating with complementary internal service providers and customers, developing new capabilities, transitioning developed applications and services to an operational state (and in some cases operating services), and overseeing costs to the user for operational services. By closely integrating new KM services with existing services, a small KM team can provide key support to a large community. For example, the KM team at JPL consists of 12 people supporting an onsite population of 5500, with over 1000 offsite partners.

SYSTEM ENGINEERING

Critical to stitching together a variety of endeavors under knowledge management, system engineering oversees testing and monitoring tools, security engineering, and the technical review of applications as they mature through their lifecycle from development to operations. Providing technical oversight, the system engineering team tackles interoperability, development, operations, and maintenance of KM services and tools.

STANDARDS

When it formed, JPL's KM Project had a choice to either move toward consolidation of distributed systems into single applications (move everyone to product X) or to build a federated architecture that allowed local solutions to be part of a larger system. Although it is a more time-consuming choice, JPL took the latter path, opting to emphasize the use of standards and a federated architecture. This consumes more labor in having to reach out, meet with, and negotiate with many smaller application providers, but has the potential to pay off in the long run with a more rigorous, customer-driven system and functionality. As a result, the work conducted in the standards area is essential.

The first deliverable for the Standards Working Group was a set of core metadata (http://step.jpl.nasa.gov/) based on the Dublin Core, that was agreed to by most of the key publishers and document repository custodians. Slow but significant progress has been made in migrating existing repositories to the new metadata scheme. This has laid the groundwork for a more efficient and thorough search capability across the organization.

In addition, a great deal of time has been spent in the area of engineering standards. Commercially available solutions for the exchange of engineering data are very expensive, and KM chose to invest in the advocacy of standards rather than betting on a single vendor. Because engineering data is transferred amongst JPL's many partners, this advocacy goes way beyond the boundaries of NASA—Lockheed Martin, Ball, and others need to also adopt similar standards. Taking leadership for

NASA in the international standards group for STEP (standard for the exchange of product model data), KM hosts an international workshop each January to promote the use of standards in aerospace.

DOCUMENT AND DATA MANAGEMENT

The Document and Data Management aspect of KM looks at the entire lifecycle of information objects and what is necessary to manage and support a rich authoring environment. Some of the current offerings in this area are an on-site hosted electronic library, built upon Xerox's DocuShare product. With 6500 users, 75 distinct organizations, and 75,000 published objects, the "Project Library" is the largest and

You Don't Have to Be a Rocket Scientist...

The Knowledge Management Program's Project Library system at JPL is used by 5000 customers around the world to help manage documents for flight projects. The new project manager of Mars '05 was meeting with the Project Library customer representative. She had a stack of papers three feet high—it included NPG 7120, ISO 9001, NPG 2810 on Information Technology Security, JPL's Policy on Document and Data Control, NARA Guidelines, and many, many others.

She told him, "You and all your project members need to be experts on every requirement in this stack, and then find, buy, and operate a system that lets you securely share information with your international partners. Oh, and there are overlaps and redundancies in many of these requirements. On the other hand, you can pay a small monthly fee for a Project Library, which we will operate for you. While it's your responsibility to make sure these requirements are met, using a Project Library will streamline meeting those requirements." The conversation continued, "Does it cover the archive requirements?" "Yes." "What about controlled records?" "It's in there."

After a handshake, a service agreement, and one week, the Mars '05 Project had an online, shared workspace, tailored for their specific partnerships and work breakdown structure. Built upon Xerox's DocuShare system, the structure supports ISO9000 through automatic creation of a Master Controlled Documents List. At the end of the mission, project documents will be moved to an online archive, incorporating requirements for records management, so that other projects will be able to learn from the Mars '05 successes.

—Manson Yew, Jet Propulsion Laboratory

first KM offering. This service also includes an electronic archive for all project-related information, as well as the processes for selecting objects for archive both during and after the project lifecycle. As this service matures, KM will offer an authoring environment that allows collaborative tools, templates, and guidelines for developing information with NASA's many partners around the world.

KNOWLEDGE NAVIGATION

Ensuring that people can find and access information is critical to sharing knowledge in a large organization that is geographically dispersed. Navigation is responsible for maintaining JPL's internal home page, previously a hand-coded web

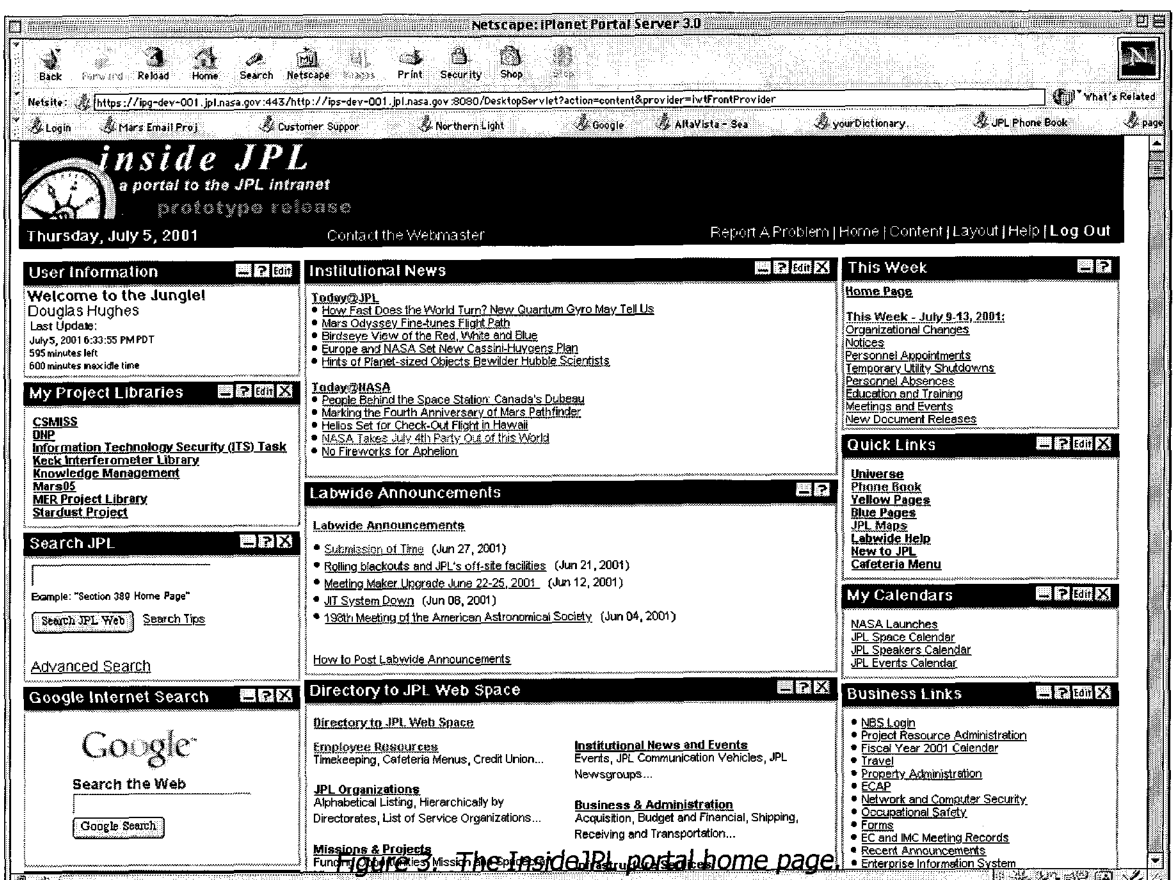

Figure 5. The InsideJPL portal home page.

site. The next generation for the internal home page, currently in beta release, is an enterprise information portal. This portal, InsideJPL, is built on a COTS application from iPlanet (a Sun, Netscape, AOL alliance) (Figure 3). As with all COTS applications, customization to the JPL environment was necessary in a variety of ways, including automated data feeds for news channels, search engine optimization (originally using Verity and then finalizing on iPlanet's Compass product).

This portal is the first step in attempting to bring some structure to the WWW (wild west web) in a typical corporate intranet, like JPL's. In addition, it lays the groundwork for content management, paves the road for one-stop publishing to multiple systems, and provides an integrated front-end to multiple KM systems such as the experts' directory, search engine, external subscriptions, and internal content. The goal in the portal development has been to

- Enhance the general user's ability to quickly find useful, accurate information that is electronically available
- Provide a scalable hosting infrastructure architecture and design
- Provide a "cookbook" for preparing project and organization elements (building blocks) for integration into a portal environment, including templates and guidelines for information publishers and consumers
- Provide a portal team framework for ongoing development and maintenance

KNOWLEDGE CAPTURE STUDIES

At the heart of knowledge management lies the study of how and why we capture those things that lead us to knowledge. Acting primarily as the research and development branch of JPL's KM Project, Knowledge Capture Studies investigates forward-looking, but near-term, opportunities that can make a targeted impact on JPL's missions. Staffed by in-house flight project personnel and professors from the University of Southern California, Knowledge Capture has delivered a Technical Questions Database focused on providing key questions in preparation for critical reviews during a project's lifetime. Gleaned from recognized experts, these questions supplement face-to-face reviews with experts that may either be retired or unable to attend.

In addition, early work in Personal Knowledge Organizers is exploring how to capture an individual's tacit and experiential knowledge before a job transition or retirement. A pre-defined structure elicits an individual's knowledge about how JPL's culture and missions were affected by significant events, what time cycles are critical in their job, and what key artifacts and publications they have produced or reference frequently.

Finally, a survey and analysis of the mentoring environment is leading to some interesting findings and recommendations to reinvigorate and realign the approaches taken to mentoring in the past.

COLLABORATIVE ENVIRONMENTS

The majority of knowledge at JPL is created by small teams working together to conduct research, solve an engineering problem, or analyze scientific or administrative data. To support such knowledge creation, KM is exploring how to provide tools for synchronous and asynchronous collaboration, training for working in virtual teams, and collections of team information to support each team building upon the knowledge gained by its predecessors. The intent is to establish a first-generation collaborative environment for virtual teams that would include partners, investigators, and key vendors. An initial offering includes an integrated voice- and data-conferencing package that provides easy, web-based scheduling and e-mail agendas and reminders.

EXPERT CONNECTIONS

Sometimes it's not enough to find articles or information published by the expert—sometimes you need to find the expert. In this case, KM needs to provide or point to the directories of key personnel who have in-demand expertise at an organization. JPL's Know Who is built on an in-house developed application that allows users to seek experts either by name or by browsing through a tested taxonomy of JPL areas of expertise. Key personnel or areas of expertise are supported by entering initial profiles. Profiles are self-maintained and contribution is voluntary for the majority of employees.

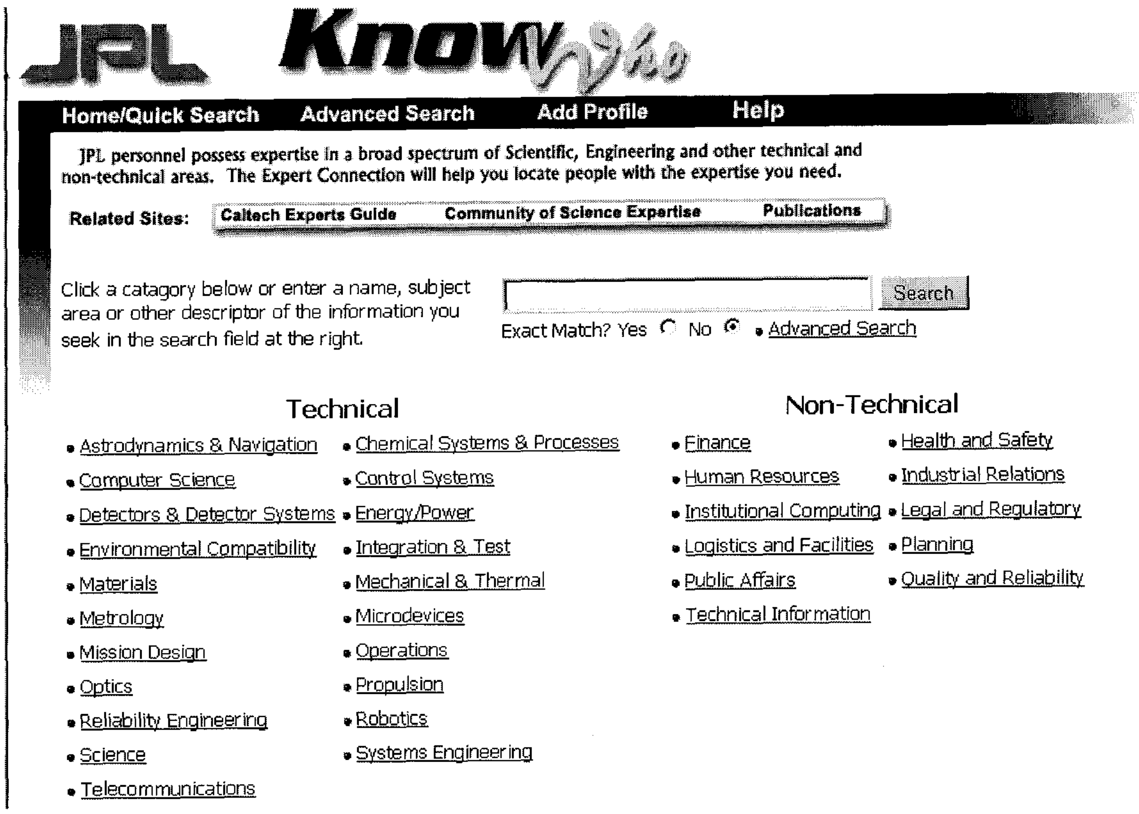

Figure 4. The KnowWho experts database.

SUMMARY

The goal of much of this work at JPL and NASA is to support communities of practice. Whether that community is designing a rocket, operating a spacecraft, understanding a physical phenomenon, or discussing stellar observations, there are certain characteristics that hold true. Such communities arise from diverse cultures, geographic locations, and time zones and, as such, require some basic supporting capabilities to meet and work effectively.

The compelling need for better knowledge management arises from the needs of the projects, programs, and communities in NASA. The drive toward smaller, faster missions has forced projects to "hit the ground running". In order to do this, all the infrastructure, processes, and information environment need to be easily adaptable and quickly applied to those new teams that need it. If KM is done correctly, the use of such processes and tools also helps NASA comply with the regulatorly alphabet soup requirements of ISO, GPEA, ITAR, EAR, and others[7]. Taking the burden of day-to-day compliance of these off the shoulders of the projects would be a key delivery of a good Knowledge Management program at NASA.

> Knowledge is of two kinds.
> We know a subject ourselves, or we know where we can find information upon it.
>
> **—Samuel Johnson**

NASA KNOWLEDGE MANAGEMENT TEAM MEMBERS

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[7] ISO = International Standards Organization; GPEA = Government Paperwork Elimination Act; ITAR = International Traffic in Arms Regulations; EAR = Export Administration Regulations

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